Microgranulometry and Methods of Applications

BACKGROUND OF INVENTION

[0001] During oil and gas exploration conventional granulometry analysis is a time consuming, logistically complex procedure. It requires the transportation and storage of a large number of samples of the rock cuttings produced during drilling to the laboratory. Conventional practice is to have a field worker manually scoop a shovel full of the cuttings as they fall off of the shaker table (the part of the drilling rig which separates the rock cuttings from the drilling fluid so that the fluid can be reused). The sample shovel-full is poured into a canvas bag and transported from the well site (which is typically remotely located) to a laboratory. Conventionally, a series of tall, wide cylindrical containers are used to separate the cuttings by particle size and density. The sample is combined with water and poured into a container. At a predetermined interval the upper portion of the partially settled sample is siphoned off and allowed to settle in a second container. This procedure is repeated until the size of particle remaining in suspension is of

a desired size. Next, all the containers are dried and weighed using an analytic balance. The quantity of specific grain sizes is tabulated for interpretation. It is impractical to perform conventional granularity analysis during modern high speed drilling. Consequently, various down hole logging tools are used in place of conventional granulometry analysis to assess porosity and permeability.

[0002] Exploration focuses on the productivity of a potential reservoir during the drilling of a well in an unconsolidated formation. Detailed rock sampling and a corresponding granulometry analysis are the most accurate and direct method for defining the potential production horizons. Granulometry properties provide the best information for estimating the porosity and permeability of a reservoir. Unfortunately, conventional granulometry is not used in the exploration of unconsolidated formations due to the logistical problems associated with it. Instead, logging properties (which are determined using down-hole tools) are substituted for granulometry parameters when calculating porosity and permeability. This produces less accurate information about a potential production zone.

[0003] In the proposed microgranulometry, the apparatus and the process solve all the problems of conventional granulometry and produce useful, accurate information. Microgranulometry produces direct quantitative measurements of the shale, silt and sand content of the formation sample.

SUMMARY OF INVENTION

[0004] The proposed microgranulometry apparatus and process is capable of producing detailed results with a very small amount of cuttings. The micro sample is placed in micro tube 1 Fig. 1 and water is added. Then the aggregate is shaken and placed vertically in the microgranulometry apparatus Fig. 3 for further analyses. The micro tube can be passed along one or more sensors 10, 11, 12, 13 and the results are recorded on a computer.

[0005] A microscopic analysis is performed by placing the micro tube 1 in front of the horizontal microscope disclosed in U.S. Patent Application Serial No. 10/711,435, Horizontal Binocular Microscope for Vertically Gravitated and Floating Samples. This process will allow a technician to visually distinguish the horizontal borders of sand at the bottom, silt in the middle and shale/clays on the top. In some cases the colloidal substance or hydrocarbons maybe visually distinguished. A measuring scale is used to measure the vertical length of each substance in millimeters from the bottom of the test tube once the layers are defined. For example if the total sample placed in the tube, in dry condition is 50 mm and the sand is 35 mm. The silt is 5 mm. and the shale is 10 mm, then the ratio is calculated as 35/50, 5/50, 10/50.

[0006] Also the results produced may be used in calculating the environmental index (pertaining to the energy of accumulation)

and to the quantification of the relative permeability disclosed by the author in patent No. US 6,301,953 B1, Date Oct. 16,2001, Quantification of Drilling Mud Cuttings Characteristics as a Measure of a Relative Permeability.

[0007] After the analyses the micro tube 1 may be stored for further review.

BRIEF DESCRIPTION OF DRAWINGS

[0008] Fig. 1 is presenting a general view of a glass tube 1, which has a rectangular cross section A-A. This is a micro tube with milliliter scale 2. A small quantity of sample and water can be placed inside.

[0009] Fig. 2 is presenting a side view of micro tube with prepared sample after shaking. In Fig. 2 the pebbles 7 are at the bottom. A sequence of gravitationally separated particles in liquid media (from course to very fine) can also be seen in Fig. 2. These layers are: pebble 7, sand 6, silt 5, clay 4 and water 3.

[0010] Fig. 3 is presenting general view of apparatus. The tube 8.3 slides in rolling holders 8 and 9. The rolling holders consist of rolling pivot 8.1 and are suspended by spring 8.2. The gamma source and holder 10 are placed in sliding contact with the sample tube 8.3. The sonic source 11 is on the same side as the gamma source. The gamma receiver 12 is placed opposite the source to receive the unabsorbed gamma rays. The sonic receiver 13 is placed opposite the sonic source and receives the

sonic signal. The vertical screw 14 controls the precise position of tube 8.3 relative to sensors 12, 13 and sources 10 and 11. The rotating nut 15 is turned by means of sheave 16 on shaft 17, which is brought in motion by motor 18.

[0011] Fig. 4 is presenting miniature tube 28, which is made from lead and will absorb most of the naturally occurring background gamma rays. The pulsing source is comprised of motor 25 and axis 24 that rotates sphere 22 and it is comprised of a lead cover 20 and lead wall 21, which shield the gamma ray source 23, 27 is gamma ray detector. 29 are gamma beams.

[0012] Fig 5 is presenting the data table that shows the columns 5.1 - depth of the interval analyzed with microgranulometry, 5.2 – gas bubbles concentration in the test tube, 5.3 – sand quantity in millimeters, 5.4 – silt quantity in millimeters, 5.5 shale/clay quantities in millimeters.

[0013] Fig. 6 is presenting the results of microgranulometry compiled in the geological and geophysical log. On this log the microgranulometry data are graphically presented.

[0014] Fig. 7 is presenting the full log. In Fig. 7, 7.1 the textual and digital data. Fig. 7, 7.2 the information is presented in the lithological column. The other drilling and gas logging parameters are presented in graphical form as curves Fig. 7, 7.3.

DETAILED DESCRIPTION

[0015] The proposed micro granulometry apparatus and process is capable of producing detailed results with very small quantities of cuttings. This micro sample is placed in micro tube 1 and water is added. Then the aggregate is shaken and placed vertically in the microgranulometry apparatus Fig. 3 for further analyses where the micro tube is passed along one or more sensors 10, 11, 12, 13 and the results are recorded on the computer. Quarter inch lead shielding adequately blocks the background radiation noise, so that transient gamma radiation can be measured with enough resolution for distinguishing between sand, silt and shale. Good results been achieved in the field testing of the apparatus and process disclosed by the author in US Patent # 6,386,026, Cuttings Sample Catcher and Method of Use and US Provisional Application Number 60/481,381, Drilling Cutting Analyzer System and Methods of Applications, also by the author.

[0016] A microscopic analysis is performed by placing the micro tube 1 in front of the horizontal microscope disclosed in US Patent Provisional Application Number 60/481408, Horizontal Binocular Microscope for Vertically Gravitated and Floating Samples. This process allows a technician to visually distinguish the horizontal borders between the layers of sand at the bottom, silt in the middle and shale/clays on the top. The variety of sizes of sand, from coarse to very fine, is easily

recognizable under the horizontal binocular microscope making detailed and efficient description possible. The transition zone between the very fine sand and silt in aggregated sample is unrecognizable in conventional sample description. In microgranulometry the very fine sand will float down faster than the silt. This is due to the sample being ground in a mortar and pestle during preparation. Thus the silt settles on top of the very fine sand. This makes the silt clearly definable and quantitatively measurable. Similarly the aggregated components of the sample are liberated during the sample preparation and separated by the microgranulometry procedure revealing clearly definable layers. In the case of a calcareous cemented formation the sample can be washed with acid to dissolve the calcareous cement. The difference of volume (the observed height of the substance in the test tube) before and after washing yields a quantitative measure of calcareous cement. The bentonite (and other clays that increase in volume when hydrated) component of the sample can be quantitatively defined by the increase in volume of the contents of the test tube. This can be directly observed by the increase in height above the initial level in the test tube. In some cases the colloidal substance or hydrocarbons maybe visually distinguished. Heavy minerals will be clearly deposited at the bottom of the test tube. The microscopic observation under the horizontal microscope is very clear and detailed due to the optical properties of water. Gas bubbles may be observed on

the walls of the test tubes and on the cuttings if the formation is gas bearing or overpressure gas is present in sample particles. Liquid hydrocarbons can be observed on the top of the water by using fluorescent properties of hydrocarbons. Here, UV light is used to induce fluorescence. A measuring scale is used to measure the vertical length of each substance in millimeters from the bottom of the test tube after the contents have settled. For example, 35 mm, 5 mm and 10 mm measurements taken in a 50 mm high sample would be recorded as the ratios 35/50, 5/50, and 10/50. The results of microgranulometry are compiled in the geological and geophysical log Fig 6. On this log the microgranulometry data are graphically presented Fig. 7, 7.1. The textual and digital information is presented in the lithological column Fig. 7, 7.2. The other drilling and gas logging parameters are presented in graphical form as curves Fig. 7, 7.3. The petro-physical calculations maybe performed in table format with graphical correlations analyses Fig. 5. The data table presented in Fig. 5 shows the columns 5.1 – depth of the interval analyses with microgranulometry, 5.2 – gas bubbles concentration in the test tube, 5.3 – sand quantity in millimeters, 5.4 – silt quantity in millimeters, 5.5 – shale/clay quantities in millimeters.

[0017] Additionally, these results may be used in calculating the environmental index of energy of accumulation and for quantifying the relative permeability disclosed by the author in patent No. US 6,301,953 B1, date Oct. 16, 2001, Quantification

of Drilling Mud Cuttings Characteristics as a Measure of Relative Permeability.

[0018] After the analyses the micro tube 1 may be stored away for further review.